

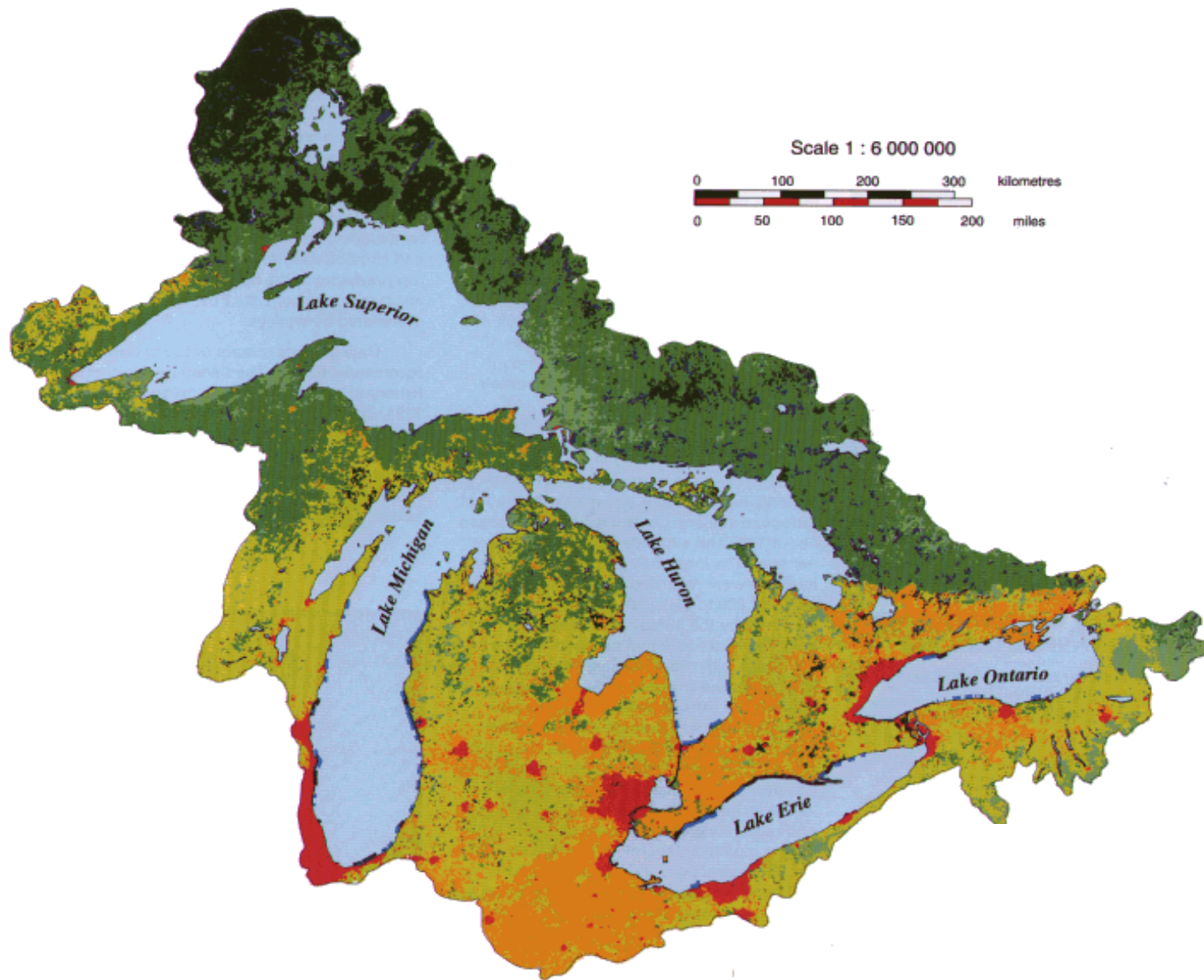
Groundwater, Agriculture and Forestry Indicators



Norman Grannemann
US Geological Survey

Groundwater





Land Use

Great Lakes Atlas
USEPA and Environment Canada

Groundwater Indicators

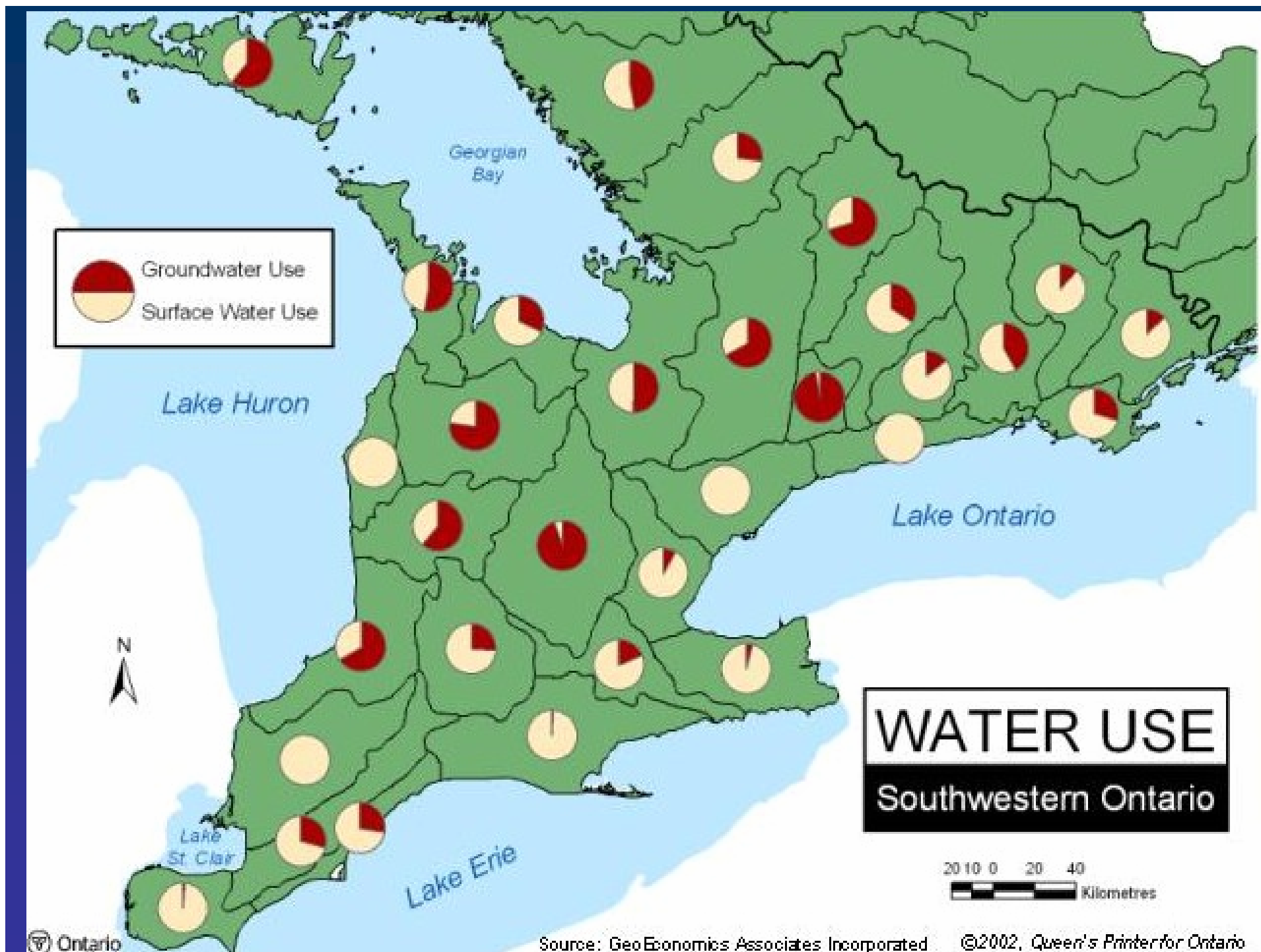
- To address *Great Lakes Water Quality Agreement*, Annex 16: Polluted Groundwater
- Based on available or easily collected data

Groundwater Indicators

1. Water Use
2. Natural and Human Induced Groundwater Quality
3. Base flow due to Groundwater Discharge
4. Groundwater and Amphibian Communities
5. Groundwater Dependant Plant and Animal Communities
6. Land Use and Intensity
7. Managing the Groundwater Resource

Water Use

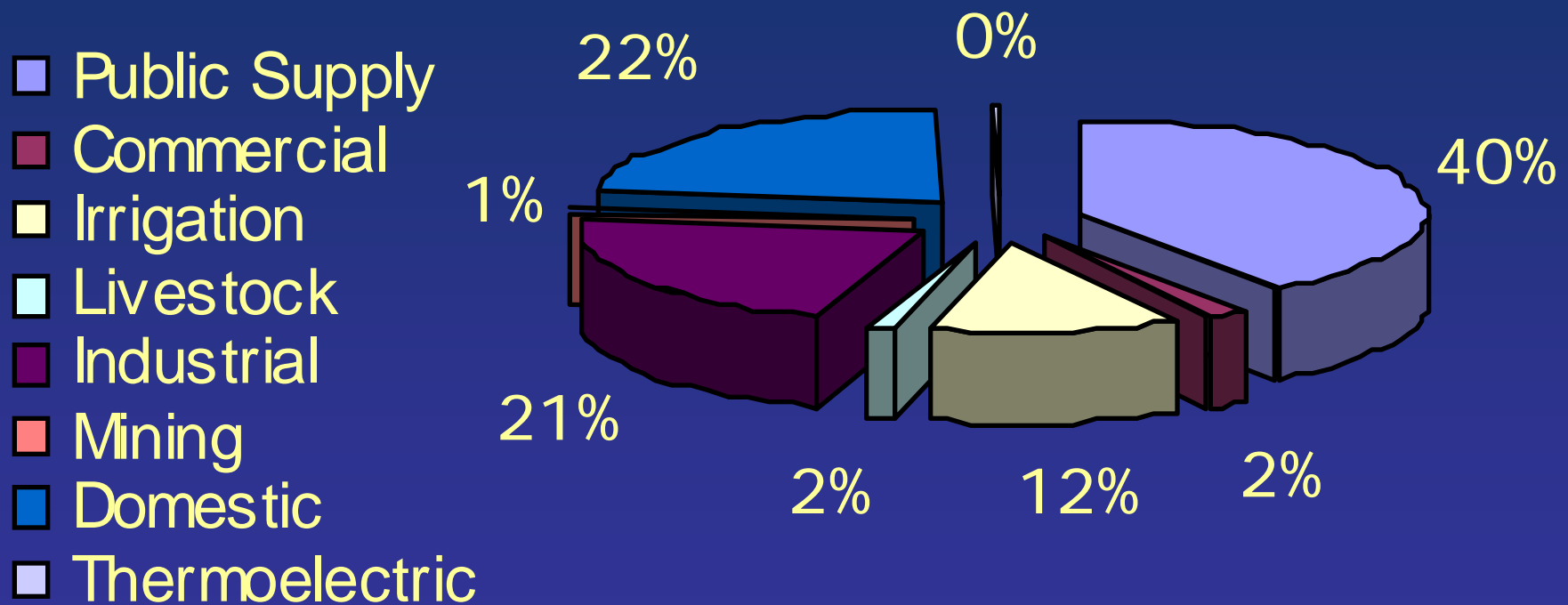
- Measures water use within political sub divisions;
- Infer the potential impacts of use and intensity on quantity and quality of groundwater.
- Also measures supply versus demand by assessing the construction of new wells or deepening of existing wells.



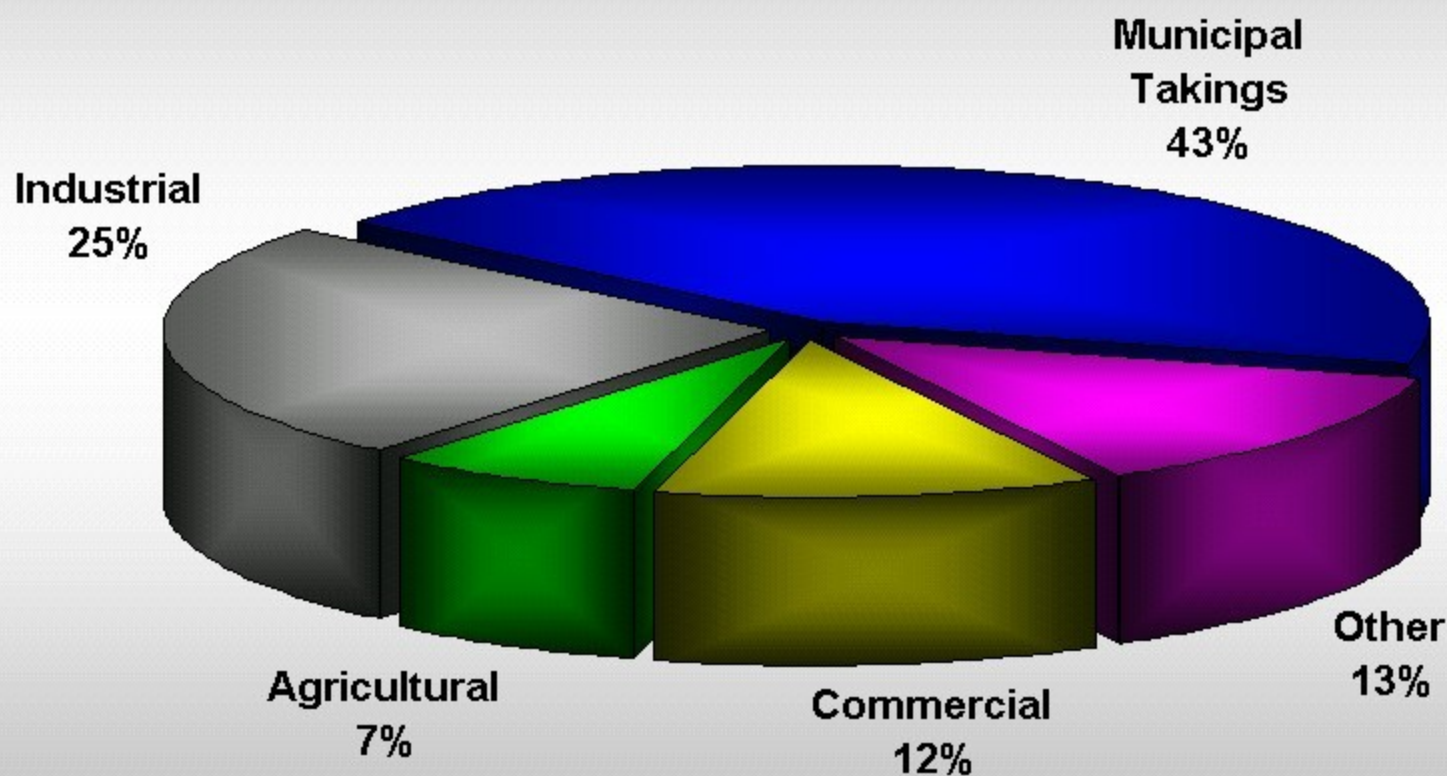


Source map: Environment Canada

Groundwater Use in Michigan, 1995



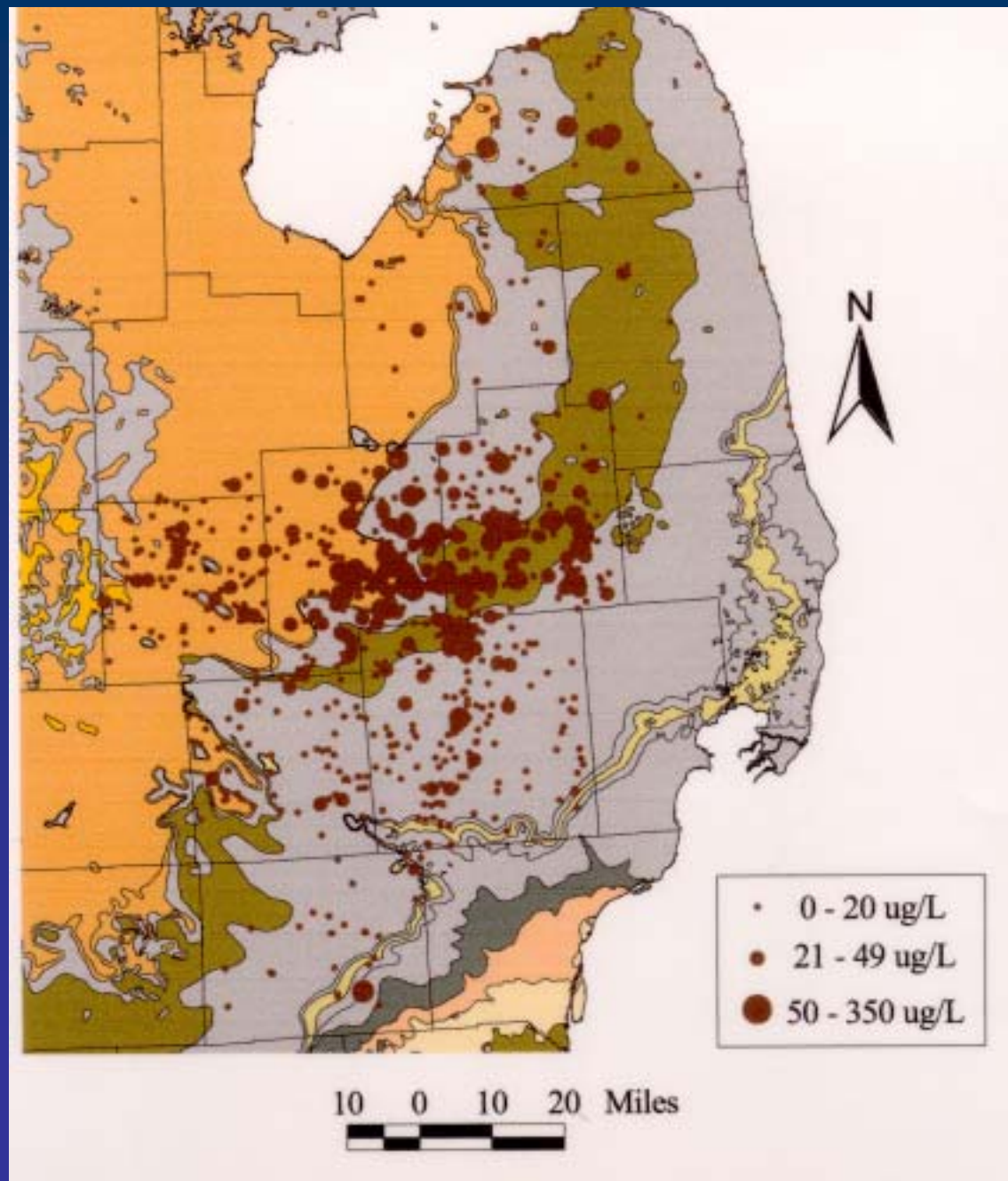
How Water is Being Used in the Grand River Watershed



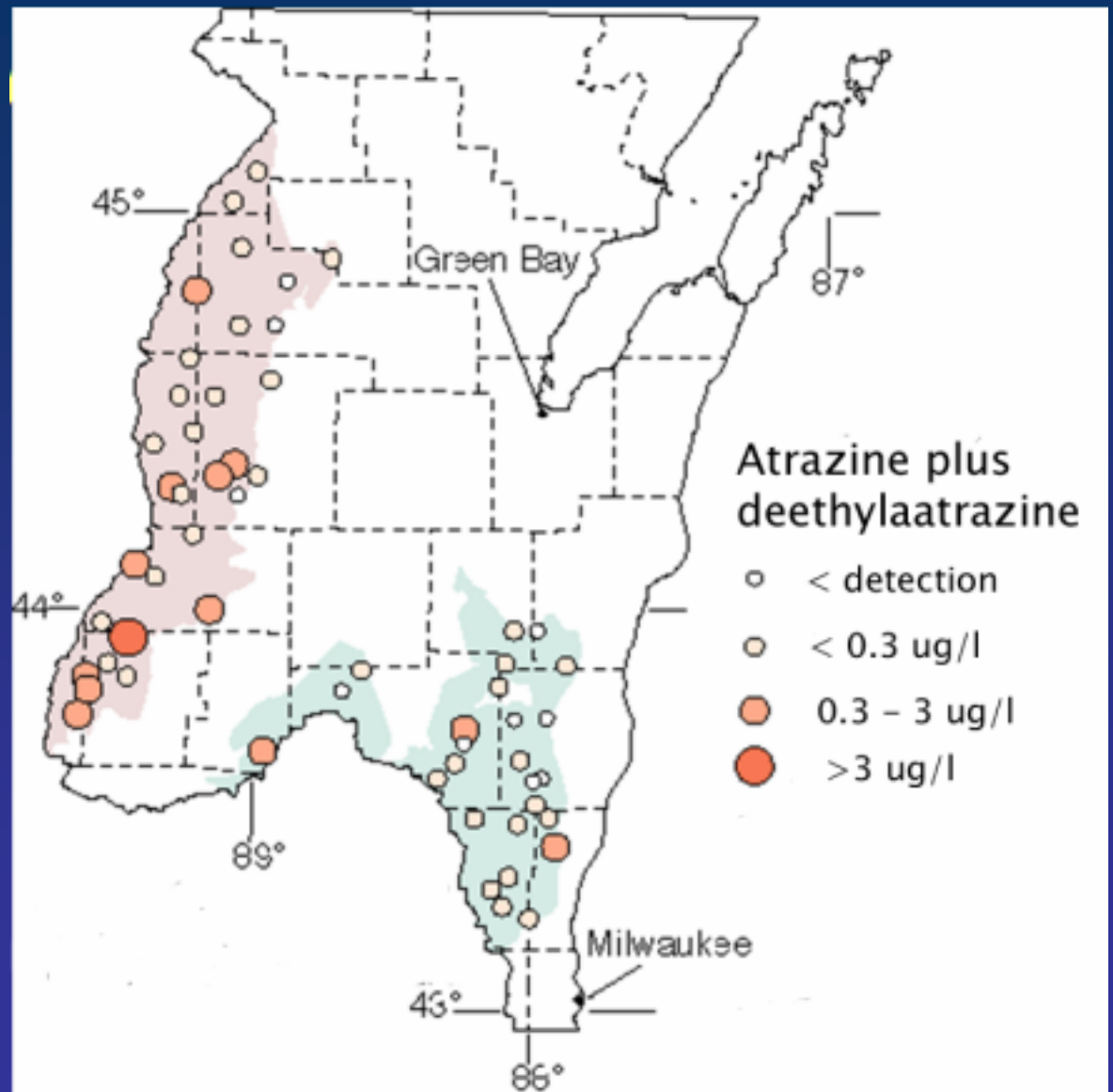
Natural and Human-Induced Groundwater Quality

- Quality of groundwater
 - Drinking water
 - Agricultural purposes
 - Ecosystem functions
- Areas of contamination
 - Remediation, prevention of non-point contamination

Arsenic in Groundwater from Southeastern Michigan



Atrazine in Groundwater from Eastern Wisconsin

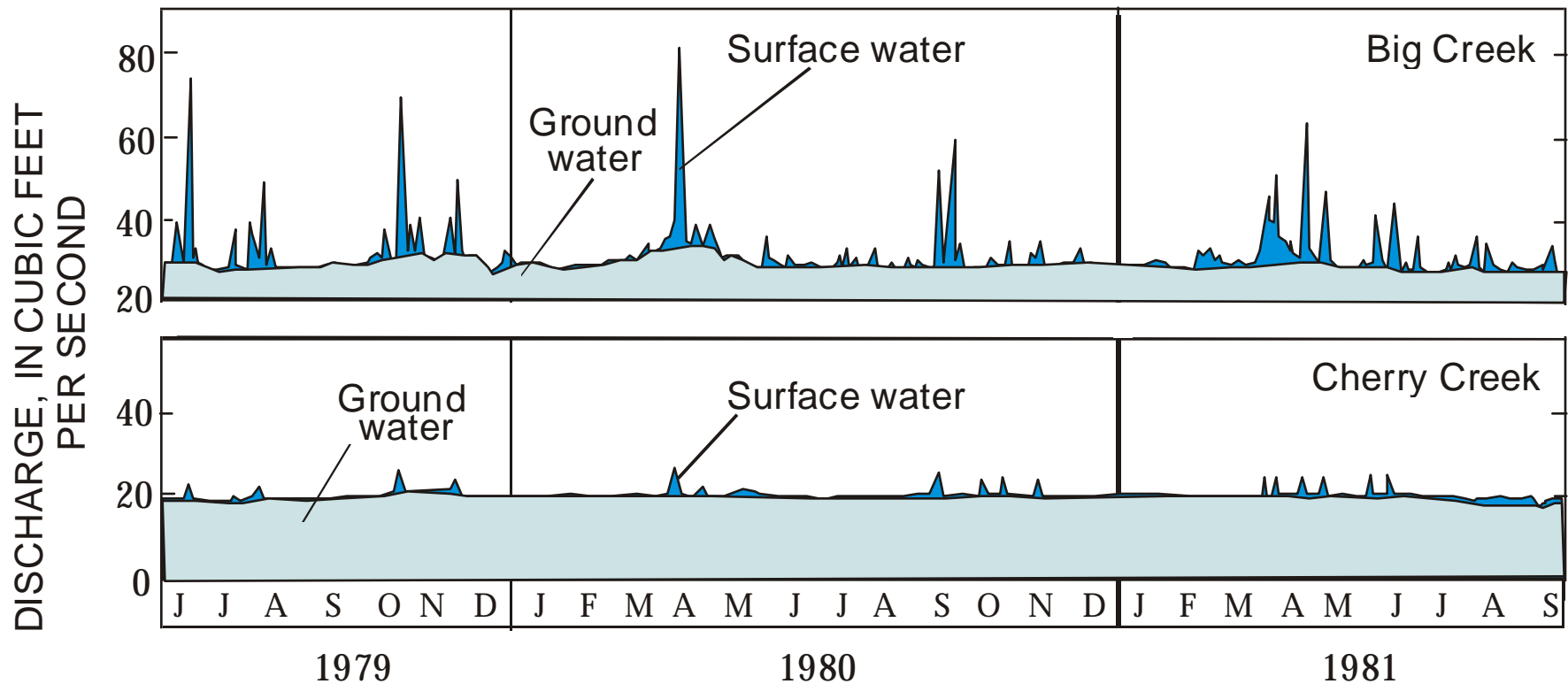


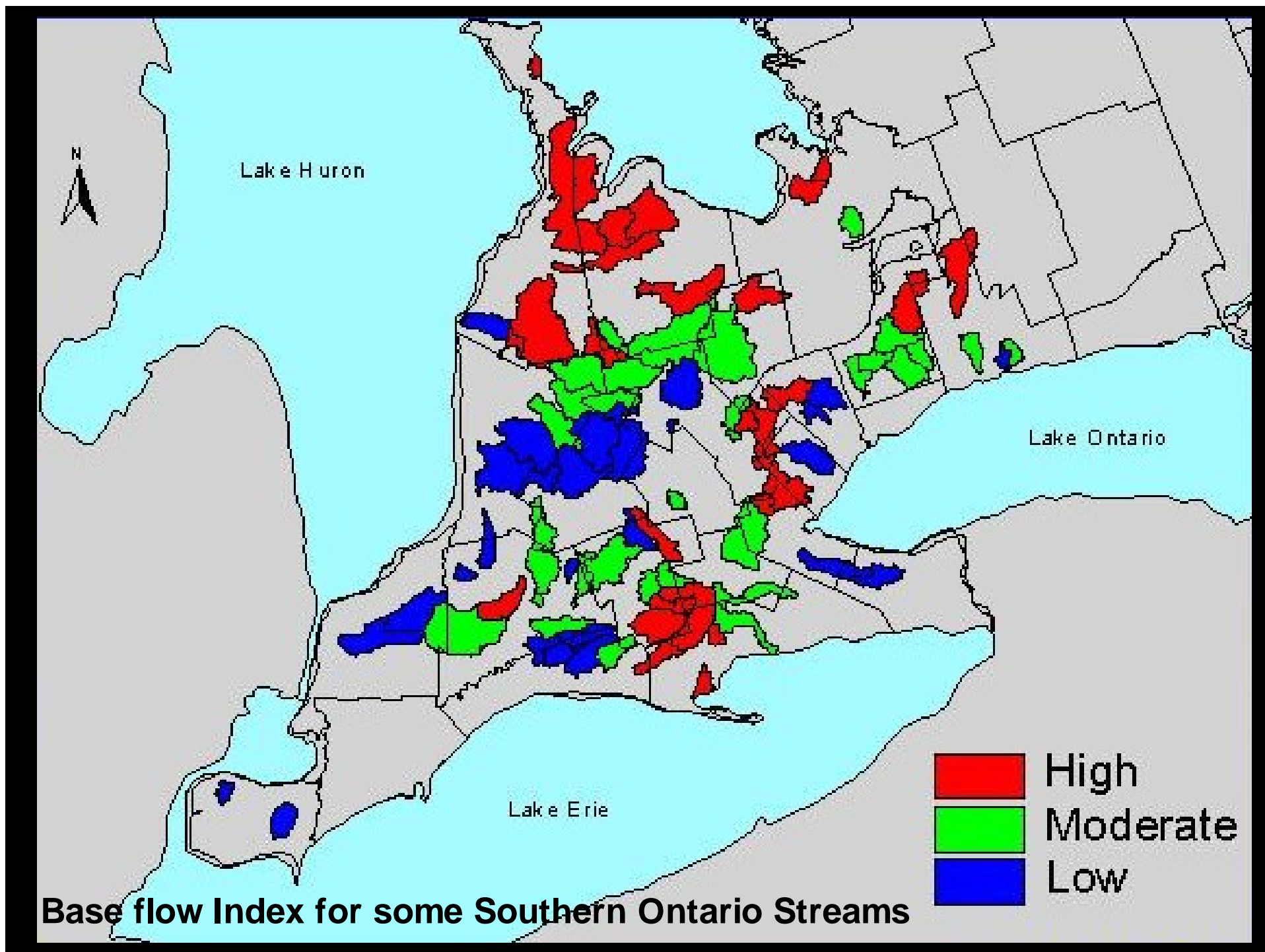
Base flow

- Contribution of groundwater to total stream flow
- Detects the impacts of humans

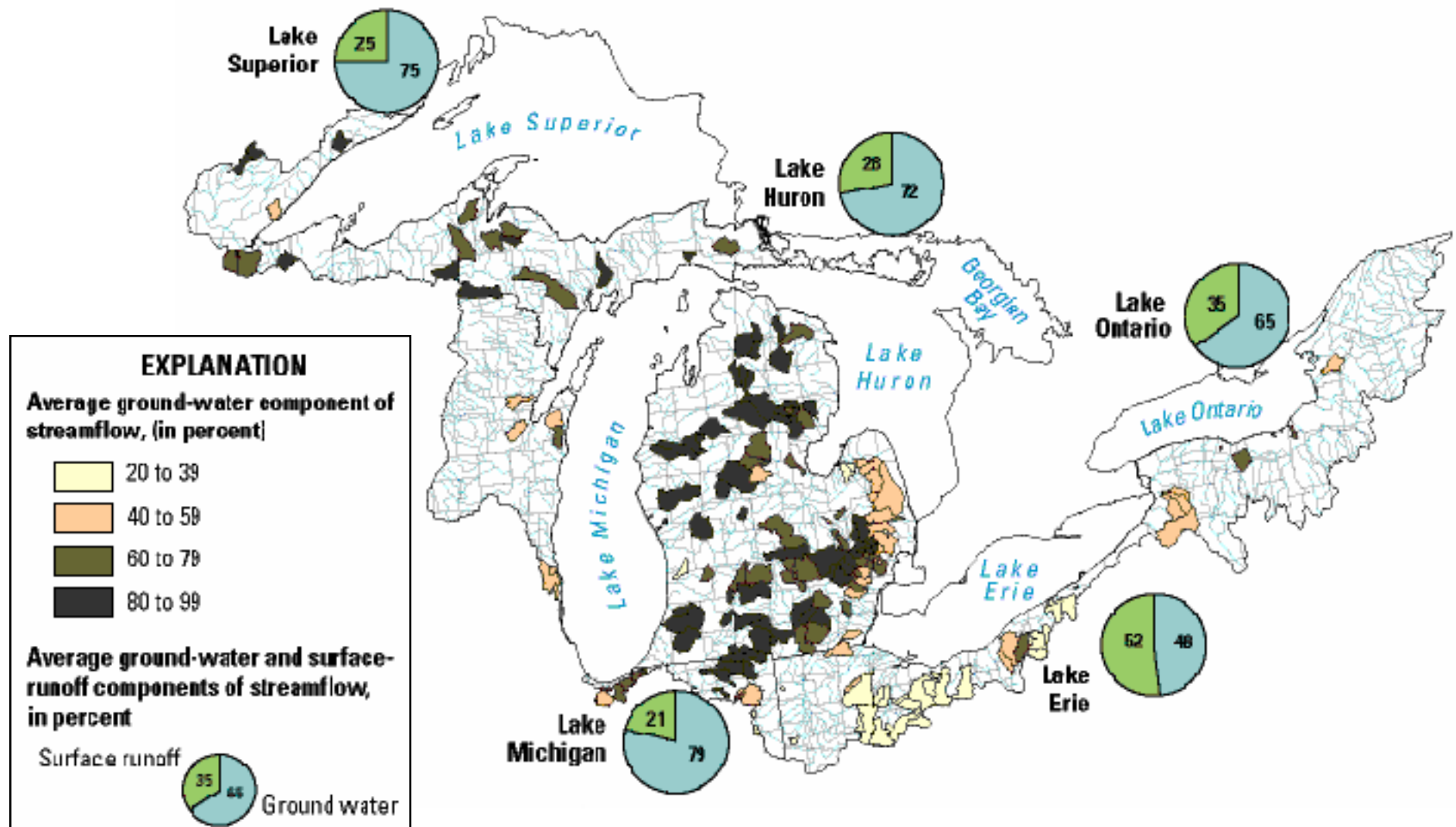


Examples of Base Flow





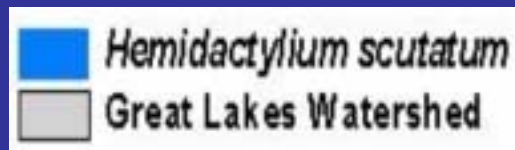
Base flow component of stream flow



Groundwater and Amphibian Communities

Four-toed salamander

- Cool water adapted frogs and salamander species
- Groundwater discharge dominates stream flows



Groundwater Dependant Plant and Animal Communities

- Assesses locations of groundwater intrusions
- Measures contribution of groundwater to stream and near shore flows
- Evaluates trophic status, food web dynamics, location of fish, wildlife, plant communities at risk



Brook Trout

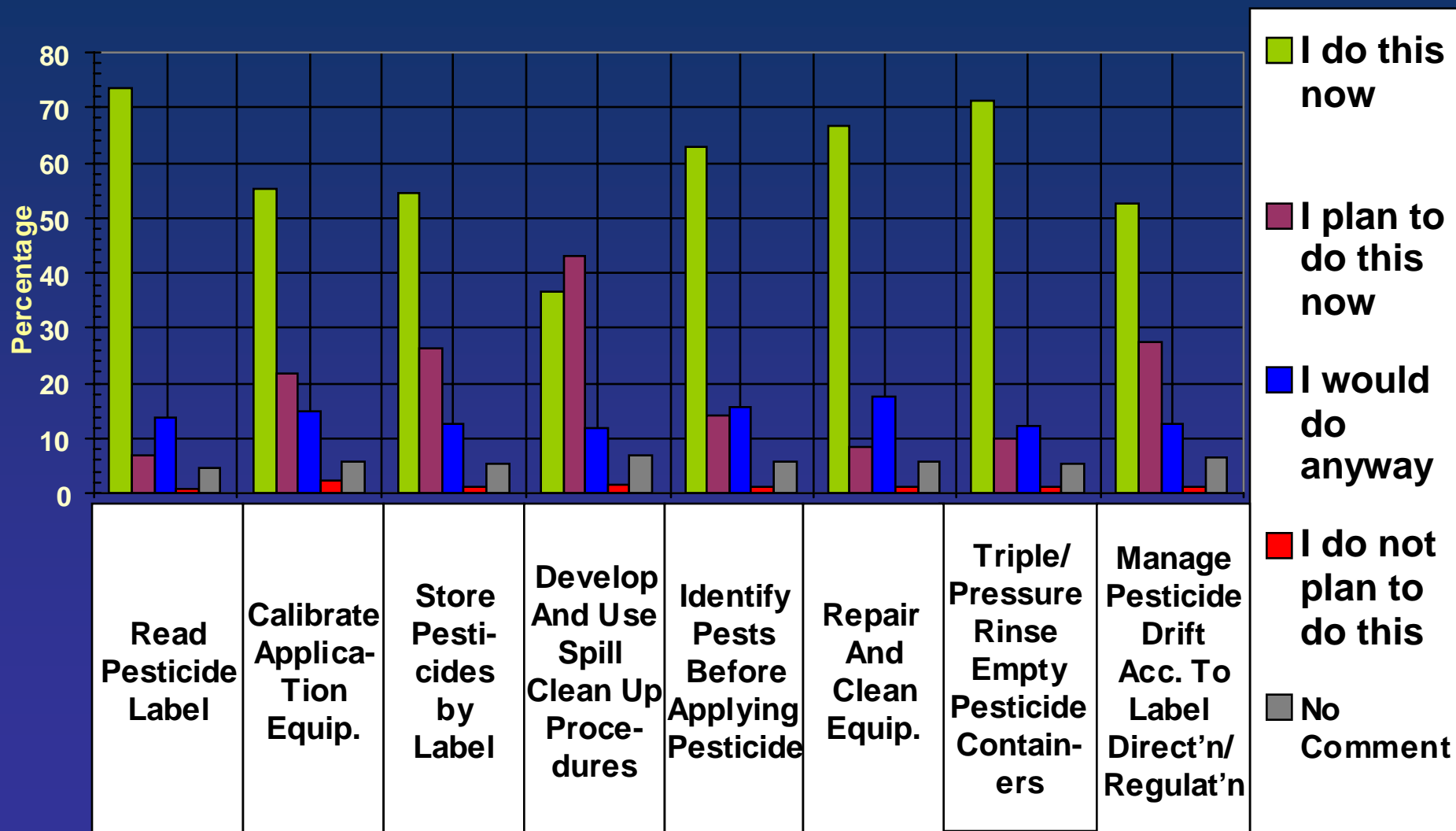
Agricultural Indicators



Integrated Pest Management

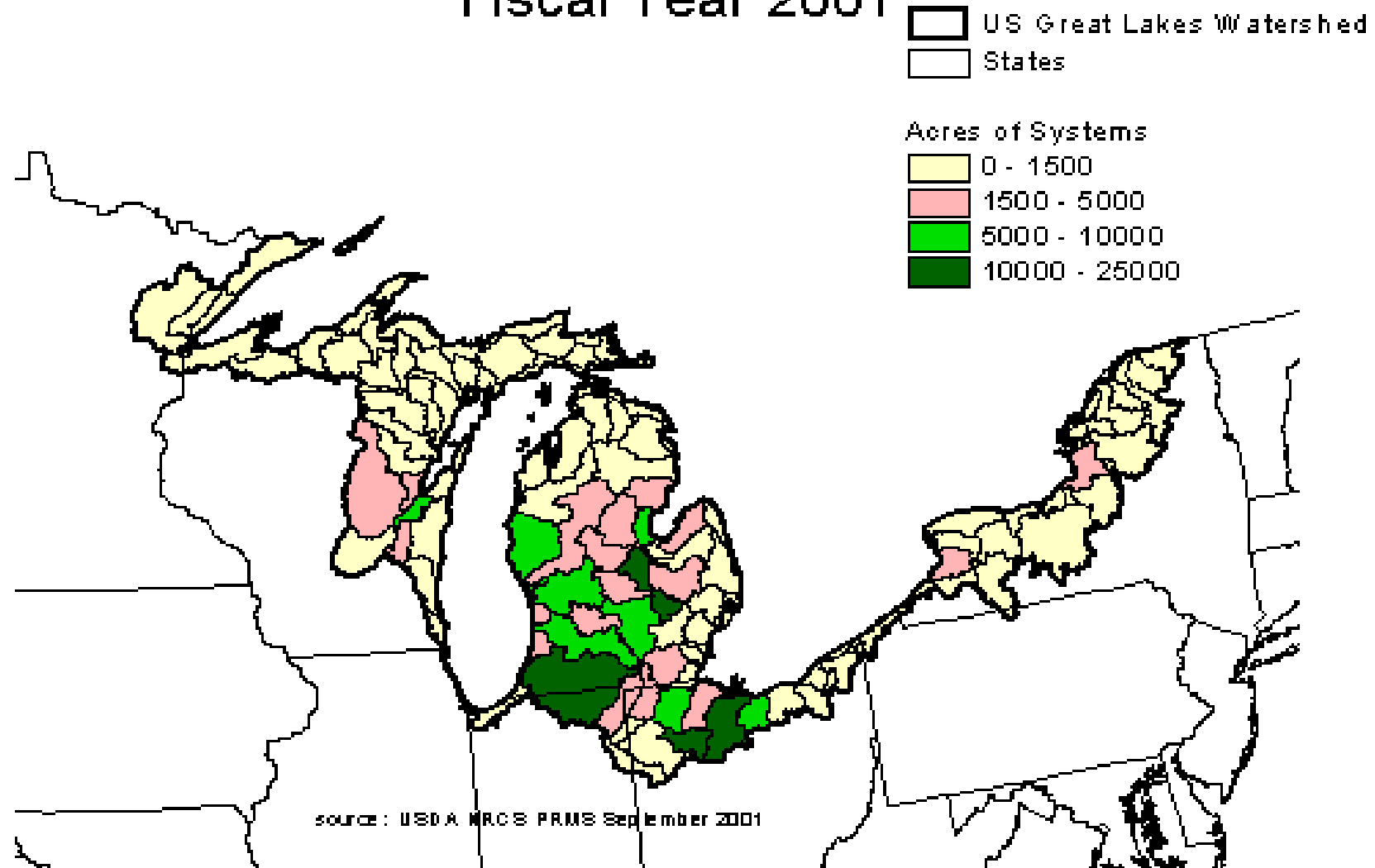
- This indicator reports the adoption of Integrated Pest Management (IPM) practices and the effects IPM has toward preventing surface and groundwater contamination in the Great Lakes Basin.

Grower Pesticide Safety Course Evaluation Results - 2000-2001



Pesticide Management Systems Planned Total Acres - Cropland

Fiscal Year 2001

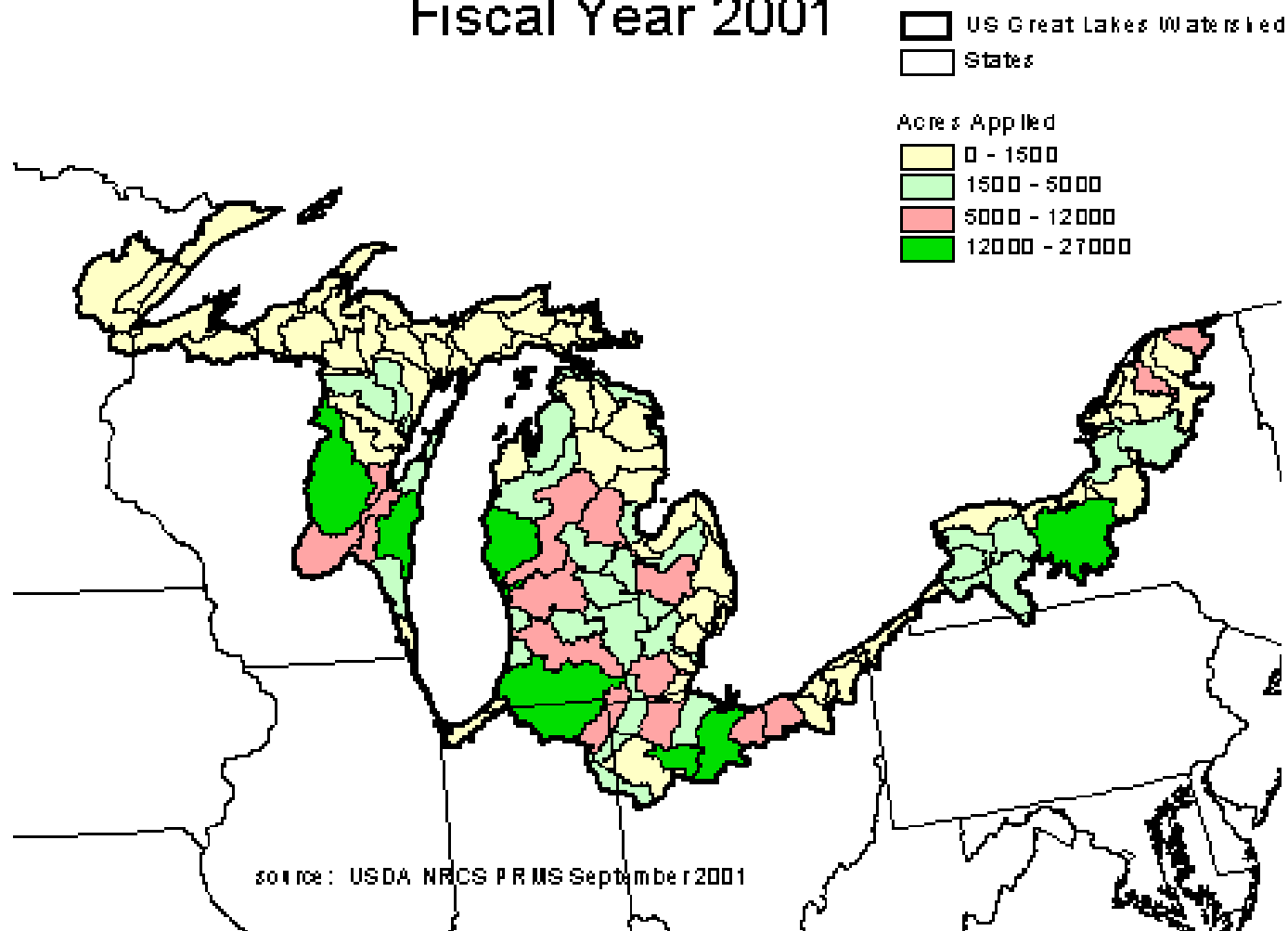


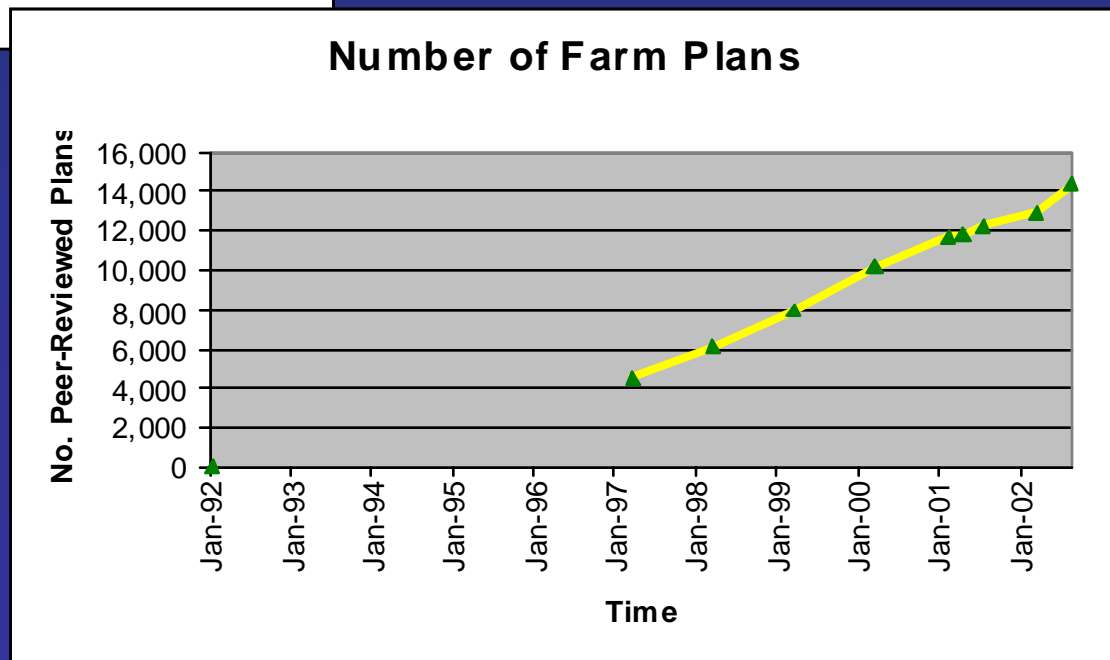
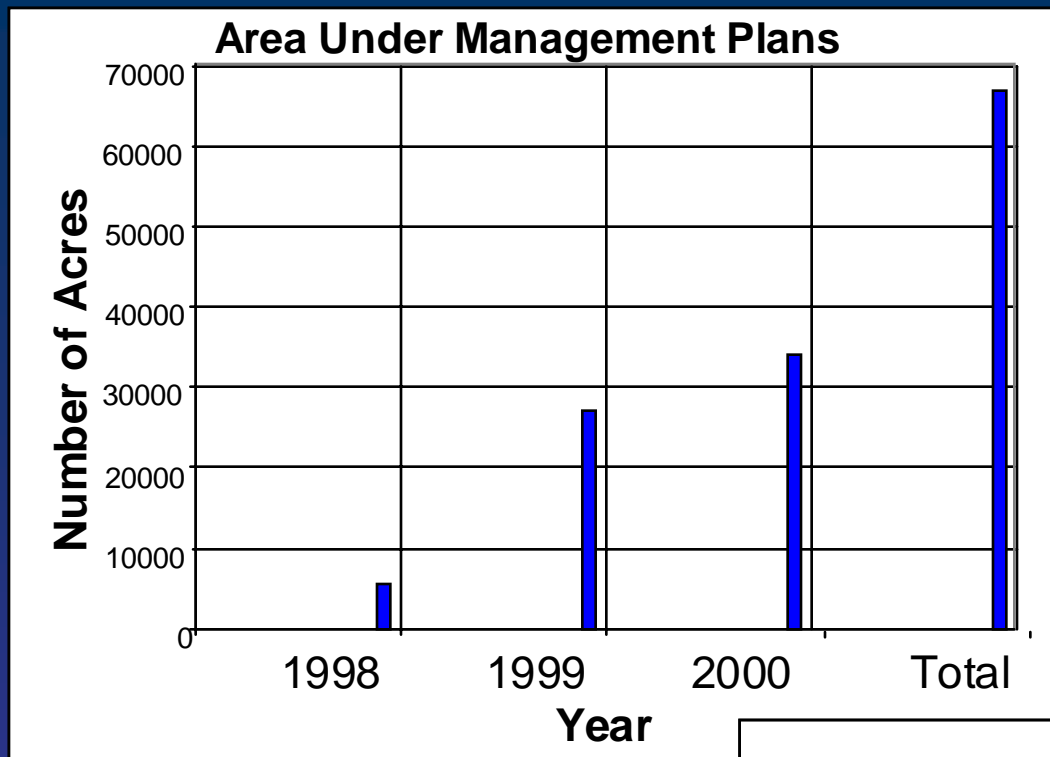
Nutrient Management Plans

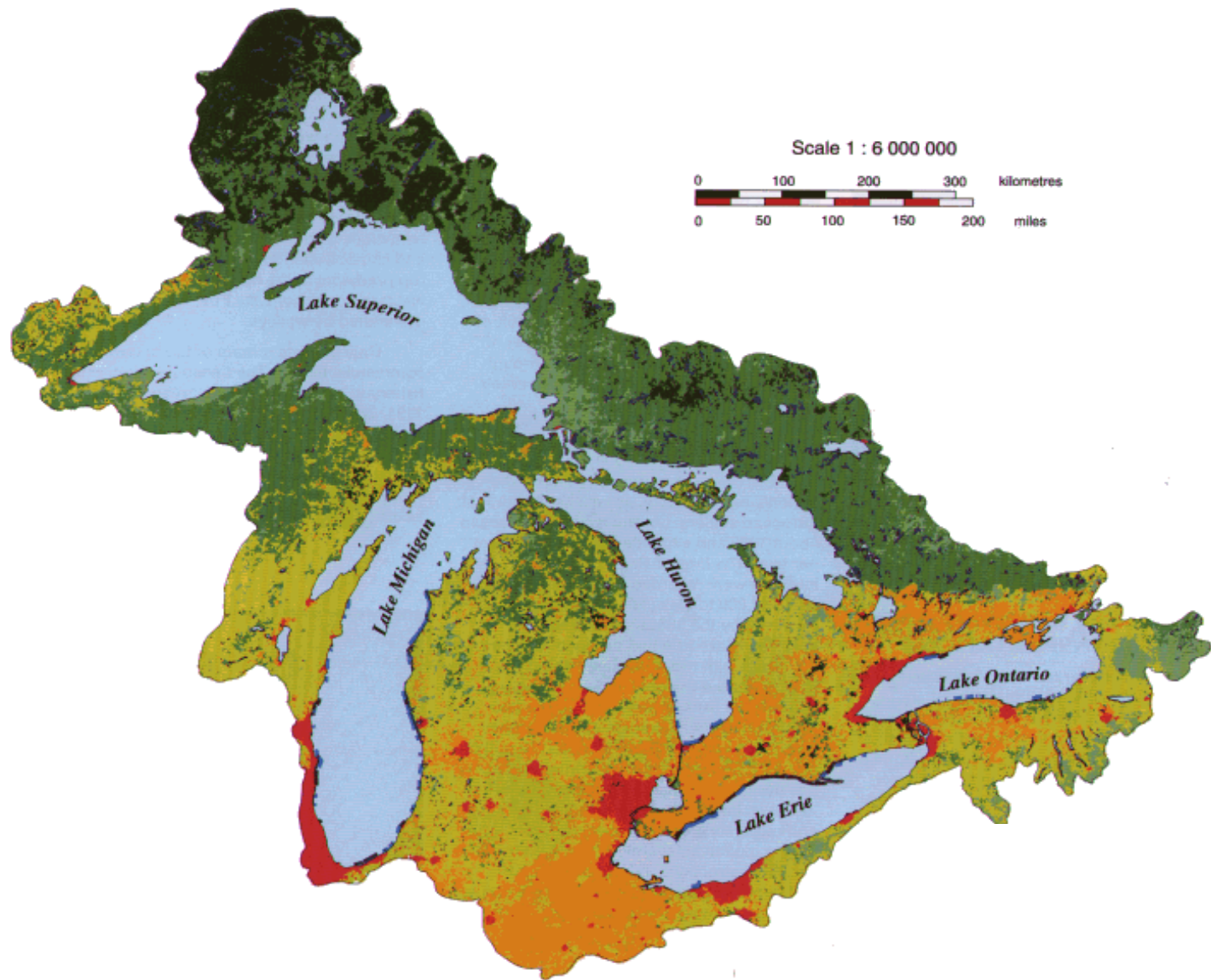
- Reports the number of Nutrient Management Plans in place, and infers environmentally friendly practices, to prevent ground and surface water contamination.

Nutrient Management Systems Planned Total Acres - Cropland

Fiscal Year 2001







Land Use

Forestry Indicators

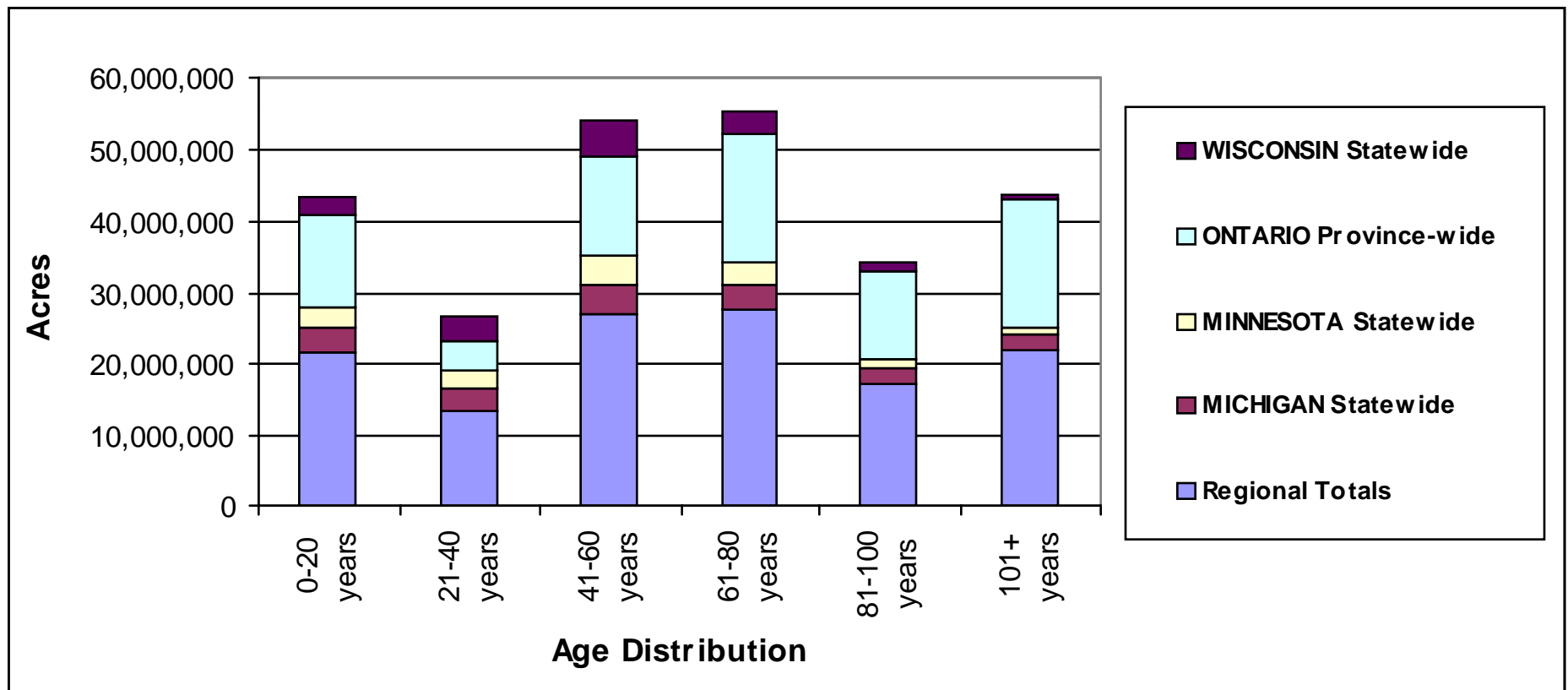


1. Proportion of forest area in each cover type and age-class (or successional stage).

2. Abundance of and trends in rare, threatened and endangered forest-based species.

3. Amount of habitat for selected forest species.

Forest Age Distribution (stand age in acres) with Regional Totals

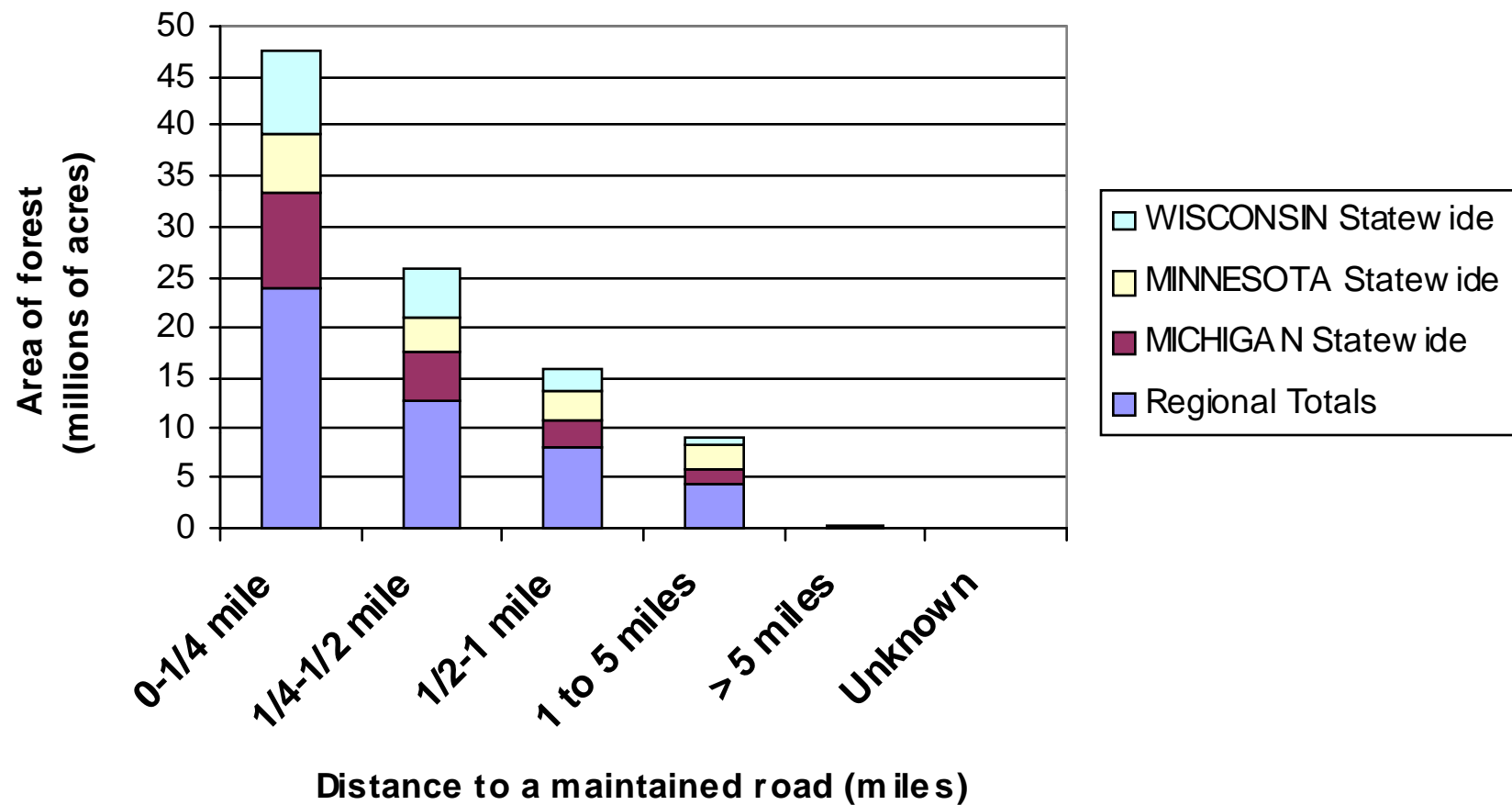


4. Trends in the area of forest land due to land use change, including deforestation and afforestation.

5. Fragmentation of forest types

6. Compliance with and effectiveness of water quality Best Management Practices

Fragmentation of Forests with Regional Totals



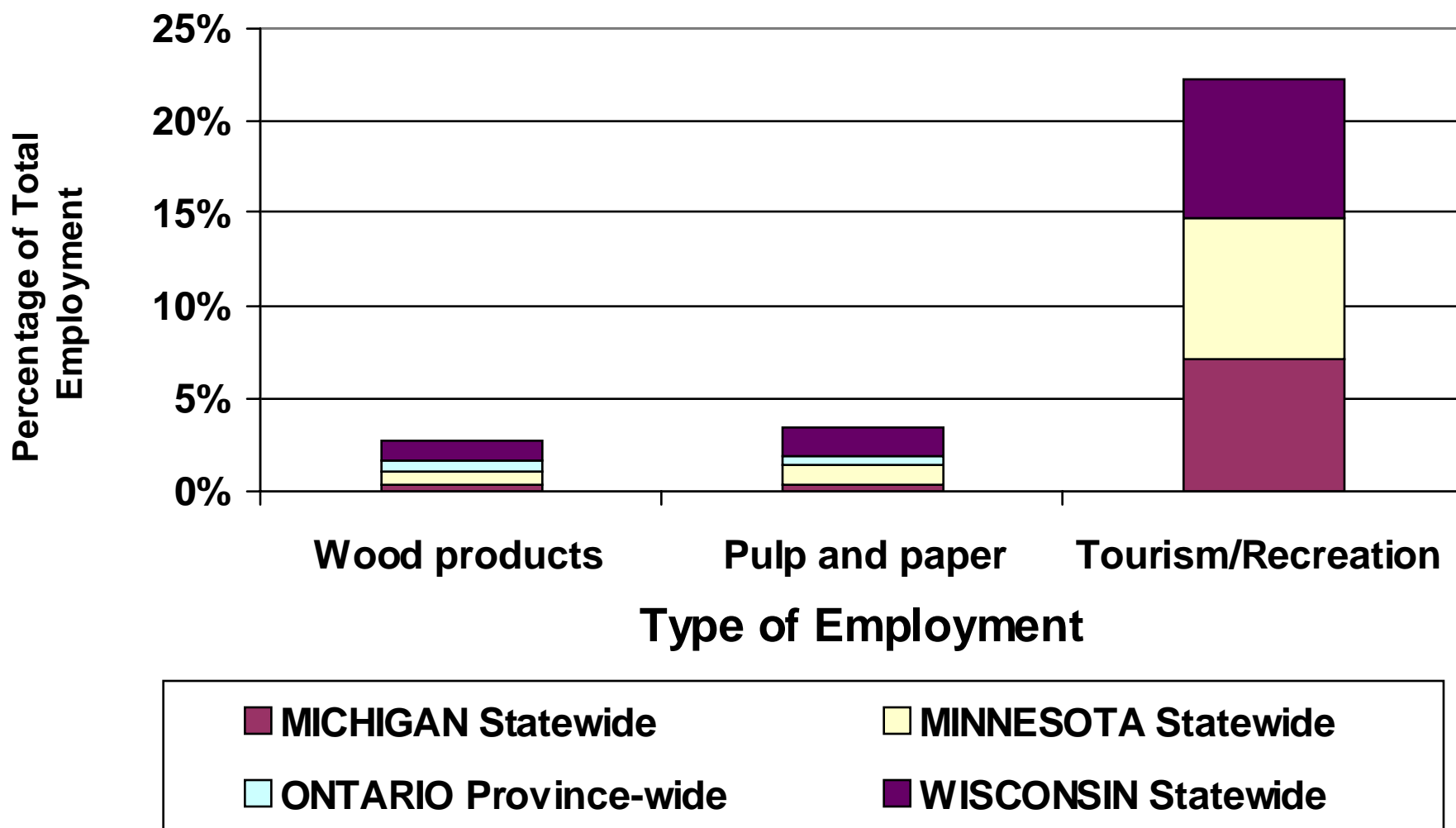
7. Area and severity of occurrence of non-native (invasive species) species detrimental to forest condition.
8. Forest land ownership and utilization. (to be defined)
9. Ranges of uses of the forest and meanings for those uses

10.Forest based employment by sector.

11.Representation of all publics in the public participation process.

12.Capacity to measure and monitor changes in the conservation and sustainable management of forests.

Percentage of the total employment in forest based occupations



Acknowledgments

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